FLEAS (SIPHONAPTERA) OF SMALL MAMMALS IN KANSAS

by

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INTRODUCTION

Fleas (order Siphonaptera) are small parasitic insects with complete metamorphosis. Adults vary from 0.8 to 5 mm. in length, are wingless, and have piercing mouthparts fitted for feeding on the blood of mammals and birds. The larvae are free living, feeding upon dry organic matter found in nest material. A complete life cycle usually requires from four to ten weeks, the adults living from eight to 35 days. Ingestion of blood is generally needed for the production of fertile eggs. Species vary considerably in their host specificity, amount of time on the host, habitat, fecundity, and disease transmission potential. The external morphology of certain fleas has been monographed by Snodgrass (1946) and the embryology was studied by Kessel (1939).

Through 1945, Hubbard (1947) reported 275 species of fleas in the United States, 246 occuring west of the 102nd meridian, and 56 east of it. Holland (1949) estimated there are 1,350 known species in the world, divided among some 200 genera.

In the early 1900's it was found that bubonic plague was transmitted by fleas. Since that time much attention has been given fleas from a taxonomic standpoint, but basic knowledge on behavior, biology and ecology is still quite meager. The discovery in 1934 and 1935 that sylvatic plague was widespread in the western United States and Canada added impetus to flea studies on this continent (Jellison, 1959). Present studies are mainly being conducted by the Public Health Service in Georgia and California and by the Army Chemical Corps at the Ecological Research Center, Dugway Proving Ground, Utah.

Fleas are perhaps best known because of the pain and subsequent

irritation caused to man and domestic animals by flea bites. Various species may live in subcutaneous cysts, cause anemia, or serve as intermediate hosts for internal parasites such as the dog tapeworm which can infect man. Their major significance however, is the ability to transmit diseases of man and animals, mainly plague, murine typhus and tularemia. Recent research has been directed at finding a weak point in the chain of transmission of sylvatic plague, the endemic form of bubonic plague present in western wild animals. The plague organisms may await only a time of human stress to become epidemic again. Sylvatic plague has been found in six western Kansas counties: Cheyenne, Rawlins, Thomas, Logan, Scott, and Morton (Public Health Service Reports, 1949), but has never been found east of the 102nd meridian. Evidence as to why the area at this meridian serves as a barrier to the eastward extension of sylvatic plague, if a barrier actually exists, may perhaps eventually be supplemented by records obtained in this study. Jellison (1959) recently reviewed the subject of fleas and disease.

The aims of the present study were (1) to conduct a qualitative survey to add to the knowledge of fleas attacking small mammals in Kansas, (2) to study their occurrence, distribution, relative numbers, and host preference to some extent, (3) to supplement the field data by bringing together scattered records of fleas in Kansas, published and unpublished, and (4) to compile a comprehensive list of flea genera and species in Kansas.

Such information is prerequisite to studies on disease transmission, ecological evaluation and basic flea-host research, and should contribute facts concerning the ectoparasitic fauna of small mammals to the much more comprehensive body of material gathered in the studies on population dynamics of wild animals now being conducted in Kansas. Because of the role of fleas as pests and vectors of disease, any facts accumulated about them

have public health significance.

REVIEW OF LITERATURE

In widely scattered literature, 21 species of fleas have been reported as being collected in Kansas. Jameson (1947), in his work on the prairie vole, collected eight species from seven small mammal hosts and made a few observations. Enns (1947) reported one of the above species from shrews in Douglas County. Grundmann et al. (1941) reported the plague vector, Xenopsylla cheopis, from the Manhattan city dump in 1941, followed by Ackert et al. (1941) with a verification of that species overwintering here. Smith et al. (1943) reported four species. Jameson (1946) and Jellison (1945) each described a new species collected from pack rat nests at Lawrence. Trembly and Bishop (1959) recorded four species from domestic animals. Gier and Ameel (1959) found eight species on coyotes and El Rawi (1957) listed two species from rabbits. In Hubbard's (1947) monograph of western fleas only three species are recorded from Kansas. Hopkins and Rothschild (1953) reported only two species from Kansas. The Rothschild Collection of Fleas at the British Museum of Natural History, by far the largest flea collection in the world, contains records of ten species from Kansas. Nineteen species were found in the Snow Entomological Museum at the University of Kansas and two in the Kansas State University entomological collection.

Records of fleas from states near Kansas help to correlate data for this study. In Oklahoma, Ward (1933) and Eddy (1943) listed fleas from rabbit collections. Also in Oklahoma the Public Health Service (Wilcomb et al., 1952) made an extensive study of commensal rat fleas in a typhus control program and Ellis (1952, 1955) did a survey of ectoparasites on

mammals in the Wichita Mountain region. Colorado College (1911) made an early attempt at ectoparasite identification in Colorado followed solely by Eads (1949) with a collection of a few fleas there. Gates (1947) did a study on the fleas of Nebraska, and published a note on fleas in the University of Nebraska Collection (1945). Rapp and Gates (1957) published a list of fleas and hosts from the above noted study. Recent collections reported from near-by states include Iowa by Joyce and Eddy (1944); Wisconsin by Knipping et al. (1950); Indiana by Wilson (1957); Illinois by Layne (1958); and New Mexico by Holdenreid and Morlan (1956), Morlan (1955), and Williams and Hoff (1951). Dunn and Parker (1924) did an early study of fleas in Montana, followed by the more complete work of Jellison, Kohls, and Mills (1943). Noteworthy comprehensive statewide studies have been made in Texas (Eads, 1950); Wyoming (Wiseman, 1955); Utah (Stark, 1958); and New York (Geary, 1959).

In the most prolific decade, the 1940's, six of the most important contributions to the study of fleas were published. Fox (1940) in the eastern United States and Hubbard (1947) in the western United States monographed the fleas of those regions. Holland (1949) covered Canada and Ewing and Fox (1943) listed fleas in all of North America. Jellison and Good (1942) compiled the flea literature in North America to that date and Costa Lima and Hathaway (1946) published a world bibliography. In view of the increased research, Jellison et al. (1953) published a synopsis of fleas of North America north of Mexico. The most ambitious venture of flea publications in modern times is a monograph of the fleas of the world, now being prepared using the Rothschild Collection in the British Museum of Natural History. Two volumes edited by Hopkins and Rothschild (1953) have been published, six more are proposed.

MATERIALS AND METHODS

Collection of Hosts

The majority of small mammals was collected at eleven stations of the Kansas Small Mammal Census, which is directed by Dr. H. T. Gier of the Department of Zoology at Kansas State University. The standardized methods for snap-trap lines used in this survey were fully explained by Gier and Bradshaw (1957). Upon running the trap line each morning, the cooperator separated his catch, and placed individuals of each mammal species into a separate plastic bag. These bags were then sealed and the animals frozen and shipped to Manhattan for examination.

Supplemental live-trap lines were run by the writer during the summer of 1959, using traps similar to those described by Clayton (1952). These trap lines were set in areas of relatively undisturbed grassland comparable to and near areas sampled in the Small Mammal Census in Riley County.

Hosts were also obtained from fellow students from time to time for supplemental ectoparasites. A few Neotoma and Sigmodon nests were located and examined for faunal contents. Data on county of collection, date, number of each species of host and source of collection were compiled (Table 1).

Collection of Ectoparasites

Basic techniques used by various workers to collect ectoparasites from small mammals are (1) brushing (Richmond, 1951; Hopkins, 1949); (2) flotation (Lipovsky, 1951; Gering and Thomas, 1953); and (3) total dissolution (Hopkins, 1949; Cook, 1954). Ignoffo (1958) compared these techniques and found total dissolution best for the most ectoparasites, with brushing best for flea

Table 1. Collection records of host animals.

		Didelphis virginiana	Blarina brevicaude	Cryptotis parva	Scalopus aquaticus	Sylvilagus floridanus	Sciurus niger	Marmota monax	Cynomys ludovicianus	Citellus spilosoma	Geomys bursarus	Perognathus flavus	Perognathus hispidus	Dipodomys ordii	Onychomys leucogaster	Reithrodontomys megalotis	Reithrodontomys montanus	Peromyscus maniculatus	Peromyscus leucopus	Sigmodon hispidus	Neotoma floridana	Microtus ochrogaster	Mus musculus	Vulpes fulva	Urocyon cinereoargenteus
*Anderson	Nov,1959		3															6		18		1			
Cowley	Nov,1959																	29		34		1			
	Mar,1959																			2		2			
*Crawford	Jun,1959																	7		4					
	Nov,1959			1														2	2	64					
*Ellis	Nov,1959			2														12		6					
*Finney	Apr,1959									1		9		101	15										
	Oct,1959													10	41										
*Johnson	Nov,1959			3												2			10	24			1		
Kearny	Jan,1959													3	1	2		17							
	Jul,1959					2																			
*Lyon	Apr,1959															1		1							
	Nov,1959		1	1														4	1	2		3			
*McPherson	Nov,1958			4												1		4		1		6			
	Nov,1959																	1				4			
*Republic	Dec,1958															1		40		6		20			
	Apr,1959																4	12				2			
	Nov,1959		6															5		1					
*Riley	Apr,1957																					7			
	Nov,1957		9													8		25		25		16			
	Apr,1958																					5			
	Nov,1958		18													6	1	16		14		42			
	Mar,1959		2														1	13		13	4	20			
	Nov,1959		10	1												12	7	26	2	4		19			
*Saline	Mar,1959																	3							
*Shawnee	Apr,1959		1													1		10				8			
	Oct,1959		1															9		2		3	1		
Hamilton	Jul,1959								2																
Butler	Nov,1958																			37					
Clay	Nov,1959						1																		
Pottawat.	Apr,1959																								
	May,1959							1			1														
Riley	Jan,1959					1																		1	1
	Jun,1959						2																	1	
	Jul,1959		1										1						18	4	2				
	Nov,1959	1	2								1							7		1					
	Dec,1959				1	1															1				
TOTAL		1	54	12	1	4	3	1	2	1	2	9	1	114	57	34	13	249	33	262	7	159	1	2	1

*Kansas Small Mammal Census

recovery. However, in choosing and developing a workable technique one must consider the condition of the host, need for a particular group of ectoparasites, the value of the skin, and the time factor. Total dissolution of the animal skin could not be used in this study because most of the animals were to be weighed and measured and certain of the skins mounted after ectoparasites were collected.

At first, fresh killed animals were brushed carefully and then subjected to a modified flotation-recovery technique. One to six hosts, depending on size, were placed in wide mouth gallon jars, which were then filled with warm water and a teaspoonful of non-sudsing detergent added. The jars were closed and shaken vigorously for two to three minutes. Water containing the ectoparasites was then poured through a fine plastic screen (60 mesh) which retained many of the smallest larval chiggers. The animals, when subsequently dried, were in good condition for other studies. Brushing freshly caught animals before flotation is time consuming and of questionable value since flotation gets most of the mites and lice and any ticks or fleas remaining after washing can easily be found by gross examination of the wet animal. The majority of hosts in this study came to the laboratory in a frozen condition and invariably were wet from cendensed moisture and would have had to have been dried in order to have been brushed. If time had been allowed for thawing and drying, the hair would have begun to slip. The most practical method found was to put the frozen animals directly into warm water and detergent, allow them to thaw and then continue the recovery process.

Fleas were separated from the ectoparasite pools, and the lice, mites and ticks were stored in 70 per cent alcohol. The fleas were cleared in five per cent KOH at room temperature and washed in distilled water. At first, fleas were mounted from water directly into polyvinyl alcohol, (Pratt

and Lane, 1949). Better permanent preparations were obtained by mounting the fleas in Hoyer's solution (Baker and Wharton, 1952) from either water or alcohol. The latter method is satisfactory and much less time consuming than standard mounting procedures.

Supplemental data and collection records of fleas in Kansas were compiled from the literature and from specimens at the Snow Entomological Collection at the University of Kansas and the Rothschild Collection of Fleas at the British Museum of Natural History. At the British Museum, Dr. F. G. A. M. Smit compiled a list of the flea records from Kansas, and gave permission to cite them in this study.

RESULTS AND DISCUSSION

In this study, 1,023 small mammals representing 24 species (Table 1) were examined for fleas during a 12 month period from November, 1958 to November, 1959. Fleas from a few hosts collected in November, 1957 and March, 1958 were also included in the present study. A total of 1,783 fleas were mounted and identified.

For each of 19 species of fleas obtained from the hosts examined, data on county of collection, data, host species, number of hosts and number of fleas collected were compiled, and each host or host pool was given a consecutive collection number for cross reference between flea species (Table 2). Additional data on 15 of the 19 species of fleas collected and on eleven additional species of fleas and five species of hosts in Kansas were obtained from the literature and from unpublished records in museum collections (Table 3).

From records of fleas in the present study and additional records of fleas available, a total of 30 species of fleas was compiled as parasites of

Table 2. Collection records of fleas from small mammals in Kansas: Present Study.

Col. No.	County	Date	Host	No. Hosts	No. Fleas Col.
		1.[a] *Cediopsylla simplex* (Baker) 1895			
83.	Riley	VI- 7-59	*Vulpes fulva*	1	1
162.	Riley	I-26-59	*Sylvilagus floridanus*	1	3
163.	Riley	XII-10-59	*S. floridanus*	1	2
Total					6
		2. *Hoplopsyllus glacialis affinis* (Baker) 1904			
162.	Riley	I-26-59	*S. floridanus*	1	27
163.	Riley	XII-10-59	*S. floridanus*	1	15
174.	Kearny	VII-29-59	*S. floridanus*	1	10
175.	Kearny	VII-11-59	*S. floridanus*	1	4
Total					56
		4. *Pulex simulans* Baker 1895			
100.	Riley	XI- 2-59	*Didelphis virginiana*	1	1
173.	Hamilton	XII- 4-59	*Cynomys ludovicianus*	1	7
177.	Riley	II- 7-60	*V. fulva*	1	4
Total					12
		6. *Ctenocephalides felis* (Bouche) 1835			
83.	Riley	VI- 7-59	*V. fulva*	1	1
100.	Riley	XI-20-59	*D. virginiana*	1	108
Total					109

[a]Reference number applies to the particular species throughout paper.

Table 2. cont.

Col. No.	County	Date	Host	No. Hosts	No. Fleas Col.
			8. *Chaetopsylla lotoris* (Stewart) 1926		
176.	Riley	II- 6-60	*Urocyon cinereoargenteus*	1	5
Total					5
			9. *Stenoponia americana* (Baker) 1898		
8.	Riley	XI-24-58	*Microtus ochrogaster*	14	1
47.	Riley	IV- 5-59	*M. ochrogaster*	12	1
88.	Republic	XII-20-58	*Peromyscus maniculatus*	40	1
94.	Riley	XI-21-57	*Sigmodon hispidus*	25	3
95.	Riley	XI-21-57	*M. ochrogaster*	16	1
96.	Riley	XI-21-57	*Reithrodontomys megalotis*	8	1
121.	Riley	XI-11-59	*Blarina brevicauda*	1	1
122.	Riley	XI-11-59	*Reithrodontomys montanus*	1	1
124.	Riley	XI-11-59	*P. maniculatus*	10	22
144.	Riley	XI-12-59	*R. montanus*	6	3
145.	Riley	XI-12-59	*B. brevicauda*	3	27
147.	Riley	XI-12-59	*P. maniculatus*	1	2
148.	Riley	XI-22-59	*S. hispidus*	4	9
149.	Riley	XI-22-59	*M. ochrogaster*	19	27
150.	Riley	XI-22-59	*B. brevicauda*	6	10
151.	Riley	XI-22-59	*P. maniculatus*	14	14
152.	Riley	XI-22-59	*R. megalotis*	12	1

Table 2. cont.

Col. No.	County	Date	Host	No. Hosts	No. Fleas Col.
154.	McPherson	XI-20-59	M. ochrogaster	4	1
155.	McPherson	XI-20-59	P. maniculatus	1	3
156.	Republic	XI-22-59	P. maniculatus	5	
			B. brevicauda	6	7
			M. ochrogaster	1	
161.	Riley	XI-24-59	P. maniculatus	1	1
Total					152
		11. Epitedia wenmanni (Rothschild) 1904			
1.	Butler	XI-23-58	S. hispidus	13	2
4.	Butler	XI-23-58	S. hispidus	nest	2
6.	Riley	XI-24-58	P. maniculatus	6	1
9.	Riley	XI-24-58	S. hispidus	10	1
13.	Butler	XI-23-58	S. hispidus	13	1
22.	Cowley	XII-22-58	P. maniculatus	22	1
23.	Kearny	I-27-59	P. maniculatus	7	2
29.	Riley	III-24-59	M. ochrogaster	8	2
30.	Riley	III-24-59	Neotoma floridana	1	1
31.	Riley	III-24-59	M. ochrogaster	7	1
40.	Riley	III-28-59	S. hispidus	1	1
46.	Cowley	III-27-59	M. ochrogaster	2	1
48.	Riley	IV- 5-59	P. maniculatus	10	2
49.	Riley	IV- 5-59	N. floridana	1	1
69.	Shawnee	IV-11-59	P. maniculatus	10	1

Table 2. cont.

Col. No.	County	Date	Host	No. Hosts	No. Fleas Col.
76.	Republic	IV-23-59	P. maniculatus	4	2
77.	Republic	IV-22-59	M. ochrogaster	2	1
78.	Republic	IV-21-59	P. maniculatus	5	1
87.	Riley	VII-13-59	N. floridana	nest	150
88.	Republic	XII-20-58	P. maniculatus	40	27
94.	Riley	XI-21-57	S. hispidus	25	1
110.	Crawford	IX-27-59	Cryptotis parva	1	1
128.	Riley	XI-20-59	N. floridana	1	1
130.	Johnson	XI- 5-59	Peromyscus leucopus	10	1
144.	Riley	XI-12-59	R. montanus	6	1
145.	Riley	XI-12-59	B. brevicauda	3	3
148.	Riley	XI-22-59	S. hispidus	4	8
149.	Riley	XI-22-59	M. ochrogaster	19	1
150.	Riley	XI-22-59	B. brevicauda	6	1
151.	Riley	XI-22-59	P. maniculatus	14	4
152.	Riley	XI-22-59	R. megalotis	12	1
156.	Republic	XI-22-59	P. maniculatus	5	
			B. brevicauda	6	15
			M. ochrogaster	1	
161.	Riley	XI-24-59	P. maniculatus	1	2
Total					241
	12. Rhadinopsylla (Rectofrontia) fraterna (Baker) 1895				
7.	Riley	XI-23-58	M. ochrogaster	13	1

Table 2. cont.

Col. No.	County	Date	Host	No. Hosts	No. Fleas Col.
145.	Riley	XI-12-59	B. brevicauda	3	3
150.	Riley	XI-22-59	B. brevicauda	6	4
Total					8
	13. Corrodopsylla curvata curvata (Rothschild) 1915				
33.	Riley	III-24-59	B. brevicauda	1	3
43.	Riley	XI-22-58	B. brevicauda	15	1
Total					4
	15. Ctenophthalmus pseudagyrtes Baker 1904				
2.	Butler	XI-23-58	S. hispidus	nest	1
7.	Riley	XI-23-58	M. ochrogaster	13	1
8.	Riley	XI-24-58	M. ochrogaster	14	1
14.	Riley	XI-24-58	B. brevicauda	3	3
29.	Riley	III-24-59	M. ochrogaster	8	3
31.	Riley	III-24-59	M. ochrogaster	7	4
39.	Riley	III-28-59	M. ochrogaster	2	7
43.	Riley	XI-22-58	B. brevicauda	15	6
68.	Shawnee	IV-11-59	M. ochrogaster	7	1
76.	Republic	IV-23-59	P. maniculatus	4	4
88.	Republic	XII-20-58	P. maniculatus	40	1
89.	Republic	XII-20-58	M. ochrogaster	20	2
96.	Riley	XI-20-57	R. megalotis	8	1
97.	Riley	XI-21-57	B. brevicauda	9	2
116.	Pott.	VI-26-59	P. leucopus	11	1

Table 2. cont.

Col. No.	County	Date	Host	No. Hosts	No. Fleas Col.
150.	Riley	XI-20-59	B. brevicauda	6	3
151.	Riley	XI-22-59	P. maniculatus	14	1
Total					39
		18. Conorhinopsylla nidicola Jellison 1945			
151.	Riley	XI-22-59	P. maniculatus	14	2
156.	Republic	XI-22-59	P. maniculatus	5	
			B. brevicauda	6	2
			M. ochrogaster	1	
164.	Riley	XII-59	N. floridana	1	1
Total					5
		20. Monopsyllus exilis kansensis Hubbard 1943			
51.	Finney	IV- 3-59	Onychomys leucogaster	4	2
54.	Finney	IV- 4-59	Dipodomys ordii	13	2
55.	Finney	IV- 3-59	D. ordii	13	4
58.	Finney	IV- 4-59	O. leucogaster	5	25
61.	Finney	IV- 7-59	D. ordii	12	2
65.	Finney	IV-12-59	D. ordii	6	1
66.	Finney	IV-12-59	O. leucogaster	2	1
70.	Finney	IV-13-59	O. leucogaster	3	5
71.	Finney	IV-15-59	D. ordii	11	1
126.	Finney	X-23-59	O. leucogaster	41	158
127.	Finney	X-23-59	D. ordii	10	1
Total					202

Table 2. cont.

Col. No.	County	Date	Host	No. Hosts	No. Fleas Col.
			24. Orchopeas leucopus (Baker) 1904		
1.	Butler	XI-23-58	S. hispidus	13	9
2.	Butler	XI-23-58	S. hispidus	nest	5
4.	Butler	XI-23-58	S. hispidus	2	3
4a.	Butler	XI-23-58	S. hispidus	nest	6
6.	Riley	XI-24-58	P. maniculatus	6	9
7.	Riley	XI-23-58	M. ochrogaster	13	20
8.	Riley	XI-24-58	M. ochrogaster	14	21
9.	Riley	XI-24-58	S. hispidus	10	4
10.	Riley	XI-23-58	M. ochrogaster	5	3
12.	Butler	XI-23-58	S. hispidus	11	
13.	Butler	XI-23-58	S. hispidus	13	6
15.	Cowley	XI-28-58	S. hispidus	9	2
18.	McPherson	XI-30-58	M. ochrogaster	6	8
21.	Cowley	XII-22-58	S. hispidus	25	4
22.	Cowley	XII-22-58	P. maniculatus	22	13
27.	Kearny	II-21-59	R. megalotis	2	1
29.	Riley	III-24-59	M. ochrogaster	8	127
31.	Riley	III-24-59	M. ochrogaster	7	89
32.	Riley	III-24-59	P. maniculatus	4	3
35.	Riley	III-25-59	M. ochrogaster	3	29
39.	Riley	III-28-59	M. ochrogaster	2	43
40.	Riley	III-28-59	S. hispidus	1	4

Table 2. cont.

Col. No.	County	Date	Host	No. Hosts	No. Fleas Col.
41.	Riley	XI-22-58	M. ochrogaster	10	2
43.	Riley	XI-22-58	B. brevicauda	15	2
45.	Cowley	III-27-59	S. hispidus	2	39
46.	Cowley	III-27-59	M. ochrogaster	2	23
47.	Riley	IV- 5-59	M. ochrogaster	12	49
48.	Riley	IV- 5-59	P. maniculatus	10	6
50.	Riley	IV- 5-59	R. montanus	1	7
53.	Saline	III-26-59	P. maniculatus	3	70
67.	Lyon	IV- 5-59	P. maniculatus	1	1
68.	Shawnee	IV-11-59	M. ochrogaster	7	15
69.	Shawnee	IV-11-59	P. maniculatus	10	14
76.	Republic	IV-23-59	P. maniculatus	4	5
77.	Republic	IV-22-59	M. ochrogaster	2	15
78.	Republic	IV-21-59	P. maniculatus	5	8
88.	Republic	XII-20-58	P. maniculatus	40	20
89.	Republic	XII-20-58	M. ochrogaster	20	80
90.	Republic	XII-20-58	S. hispidus	6	10
91.	Riley	IV- 1-57	M. ochrogaster	7	7
92.	Riley	IV-16-58	M. ochrogaster	5	22
94.	Riley	XI-21-57	S. hispidus	25	17
95.	Riley	XI-21-57	M. ochrogaster	16	4
108.	Crawford	X-27-59	S. hispidus	13	1
116.	Pott.	VI-26-59	P. leucopus	11	4

Table 2. cont.

Col. No.	County	Date	Host	No. Hosts	No. Fleas Col.
117.	Pott.	VI-26-59	Perognathus hispidus	1	1
124.	Riley	XI-11-59	P. maniculatus	10	8
135.	Lyon	XI-15-59	S. hispidus	2	1
136.	Lyon	XI-15-59	M. ochrogaster	3	3
142.	Ellis	XI- 8-59	S. hispidus	6	1
144.	Riley	XI-12-59	R. montanus	6	4
148.	Riley	XI-22-59	S. hispidus	4	2
149.	Riley	XI-22-59	M. ochrogaster	19	14
150.	Riley	XI-22-59	B. brevicauda	6	2
151.	Riley	XI-22-59	P. maniculatus	14	3
154.	McPherson	XI-20-59	M. ochrogaster	4	11
156.	Republic	XI-22-59	P. maniculatus	5	
			B. brevicauda	6	2
157.	Anderson	XI-22-59	M. ochrogaster	1	1
160.	Anderson	XI-22-59	S. hispidus	18	3
Total					886
	25. Orchopeas sexdentatus pennsylvanicus (Jordan) 1928				
30.	Riley	III-24-59	N. floridana	1	2
38.	Riley	III-25-59	N. floridana	2	3
87.	Riley	VII-13-59	N. floridana	nest	33
113.	Riley	VII- 7-59	N. floridana	2	8
Total					46

Table 2. cont.

Col. No.	County	Date	Host	No. Hosts	No. Fleas Col.
			26. *Thrassis* sp. Jordan 1933		
51.	Finney	IV-23-59	*O. leucogaster*	4	3
63.	Finney	IV- 8-59	*D. ordii*	4	1
Total					4
			27. *Thrassis campestris* (Prince) 1944		
127.	Finney	X-23-59	*D. ordii*	10	5
Total					5
			30. *Peromyscopsylla scotti* Fox 1939		
130.	Johnson	XI- 5-59	*P. leucopus*	10	3
Total					3
Total all collections					1783

Table 3. Collection records of fleas from small mammals in Kansas: sources other than present study.

Location	Date	Host	No. Hosts	No. Fleas Col.	Source
	1.[a] Cediopsylla simplex (Baker) 1895				
Ril.&Pott.	1956-58	Canis latrans	140	31	G[b]
Douglas	1945	Sylvilagus floridanus			H[c]
Douglas	IV-14-46	S. floridanus			K[d]
Miami	III- 3-46	C. latrans			K
Anderson	XII- 5-46	S. floridanus			K
Riley	1935	"Rabbit"			Ko[e]
	2. Hoplopsyllus glacialis affinis (Baker) 1904				
Ril.&Pott.	1956-58	C. latrans	140	122	G
Gray	1931	Lepus sp.			H
Kearny	1956	Lepus californicus	64	20	E[f]
Anderson	I- 6-46	S. floridanus			K
Labette	IX- 6-46	Sylvilagus aquaticus			K
Norton	IX-24-46	S. floridanus			K
Riley	1935	"Rabbit"			Ko
	3. Echidnophaga gallinacea (Westwood) 1875				
Reported from Kansas, no locality					T[g]

[a]Reference number applies to the particular species throughout paper.
[b]Gier and Ameel (1959)
[c]Hopkins and Rothschild (1956)
[d]Snow Entomological Collection, University of Kansas
[e]Kohls (1940)
[f]El Rawi (1957)
[g]Trembley and Bishop (1940)

Table 3 cont.

Location	Date	Host	No. Hosts	No. Fleas Col.	Source
		4. *Pulex simulans* Baker 1895			
Ril.&Pott.	1956-58	*C. latrans*	140	2,197	G
Kearny	1956	*L. californicus*	64	4	E
Reno&Riley					T
		5. *Ctenocephalides canis* (Curtis) 1826			
Ril.&Pott.	1956-58	*C. latrans*	140	8	G
Miami	III- 3-46	*Vulpes fulva*			K
Riley					T
		6. *Ctenocephalides felis* (Bouche) 1835			
Douglas	1933	*Didelphis virginiana*			H
Douglas	V- 2-45	*D. virginiana*			K
Leavenworth					T
		7. *Xenopsylla cheopis* (Rothschild) 1903			
Riley	IX-40	*Rattus norvegicus*	8	20	Gr[h]
		8. *Chaetopsylla lotoris* (Stewart) 1926			
Ril.&Pott.	1956-58	*C. latrans*	140	33	G
Riley	III-12-59	*Procyon lotor*	1	12	Gi[i]
		Taxidea taxus			Gi

[h]Grundmann et al. (1941)
[i]Gier, unpublished data

Table 3. cont.

Location	Date	Host	No. Hosts	No. Fleas Col.	Source
		10. *Epitedia neotomae* Jameson 1946			
Douglas		*Spilogale interrupta*	1	3	J46[j]
Ellsworth		*Neotoma floridana*	1	4	J46
Douglas	XII-13-47	*N. floridana*	nest	1	B[k]
Douglas	X-10-45	*N. floridana*	nest	2	B
Douglas	1945	*N. floridana*	nest	32	J46
		11. *Epitedia wenmanni* (Rothschild) 1904			
Douglas	XII-13-47	*N. floridana*			B
Leavenworth	XI-27-54	*Peromyscus leucopus*			B
Douglas	IV-12-49	*N. floridana*	nest		B
Douglas	1945-46	*P. leucopus*	11/35[m]		J[l]
Douglas	1945-46	*Microtus ochrogaster*	8/414		J
Douglas	II-24-46	*P. leucopus*			K
Douglas	I-27-34	*Peromyscus maniculatus*			K
Miami	XI- 6-46	*Sigmodon hispidus*			K
Douglas	XI-11-44	*N. floridana*	nest		K

[j] Jameson (1946)
[k] Rothschild Collection of Fleas, British Museum of Natural History
[l] Jameson (1947)
[m] Number of hosts infested/total hosts examined

Table 3. cont.

Location	Date	Host	No. Hosts	No. Fleas Col.	Source
		12. Rhadinopsylla (Rectofrontia) fraterna (Baker) 1895			
Douglas	1945-46	M. ochrogaster	4/414		J
Douglas	X-15-44	Mouse nest			K
		14. Corrodopsylla hamiltoni Traub 1944			
Douglas	1945-46	Cryptotis parva	16/34		J
Douglas	1945-46	Blarina brevicauda	1/13		J
Douglas	X-11-45	C. parva			K
		15. Ctenophthalmus pseudagyrtes Baker 1904			
Douglas	1945-46	B. brevicauda	5/13		J
Douglas	1945-46	S. hispidus	2/57		J
Douglas	1945-46	M. ochrogaster	103/414		J
Douglas	1945-46	Pitymys pinetorum	11/21		J
Douglas	X-31-45	M. ochrogaster			K
Douglas	II-24-46	P. pinetorum			K
Anderson	XII- 6-46	S. floridanus			K
Douglas	VII- 8-44	Scalopus sp.			K
Miami	III- 3-46	V. fulva			K
		16. Doratopsylla blarinae Fox 1914			
Douglas	XI-10-45	M. ochrogaster			K
		17. Anomiopsyllus hiemalis (Eads and Menzies) 1948			
Barber	IV-14-49	Neotoma micropus			K
		18. Conorhinopsylla nidicola Jellison 1945			
Pott.	II-57	C. latrans	140	1	G

Table 3. cont.

Location	Date	Host	No. Hosts	No. Fleas Col.	Source
Douglas	1944-45	N. floridana	nest	231	Je[n]
Douglas	X- 1-45	N. floridana	nest	7	B
Douglas	XII-13-47	N. floridana	nest	4	B
	19. Odontopsyllus dentatus (Baker) 1904				
Anderson	III-22-47	S. floridanus			K
	20. Monopsyllus exilis kansensis Hubbard 1943				
Meade	VII-40	Onychomys leucogaster		2	Hu[o]
	21. Nosopsyllus fasciatus (Bosc) 1801				
Douglas	1945-46	N. ochrogaster	4/414		J
Douglas	XI- 2-45	M. ochrogaster			K
	22. Opisocrostis hirsutus (Baker) 1895				
Rawlins	VIII-19-50	Cynomys sp.			K
	23. Orchopeas howardii (Baker) 1895				
Marshall	I-53	C. latrans	140	1	G
Pott.	II-58	C. latrans	140	1	G
Riley	III-58	P. maniculatus			G
Riley	III-58	M. ochrogaster			G
Leavenworth	XI-26-54	Sciurus niger			B
Leavenworth	I- 8-55	Glaucomys volans			B
Douglas	X-30-45	S. niger			B
Douglas	XI-11-48	S. niger			B

[n]Jellison (1945)
[o]Hubbard (1947)

Table 3. cont.

Location	Date	Host	No. Hosts	No. Fleas Col.	Source
Douglas	1945-46	M. ochrogaster	4/414		J
Douglas	XI-1-45	Scuirus carolinensis			K
Douglas	X-18-45	S. niger			K
Labette	I- 6-47	P. leucopus			K
Morton	X-25-46	S. niger			K
Labette	I- 7-47	S. niger			K
Miami	XI- 4-45	S. niger			K
Mitchell	VI-18-47	L. californicus			K
Logan	X-25-46	S. niger			K
		24. Orchopeas leucopus (Baker) 1904			
Anderson	XII- 6-46	S. floridanus			K
Anderson	III-23-47	M. ochrogaster			K
Anderson	III-23-47	Peromyscus sp.			K
Douglas	III-16-46	M. ochrogaster			K
Leavenworth	XI-29-54	P. leucopus			K
Douglas	II-25-46	S. hispidus			K
Atchison	XI-23-45	M. ochrogaster			K
Atchison	XI-24-45	P. maniculatus			K
Jefferson	XII- 2-45	M. ochrogaster			K
Leavenworth	XII-17-54	P. leucopus			B
Douglas	II-25-46	S. hispidus			B
Douglas	1945-46	P. maniculatus	18/34		J
Douglas	1945-46	P. leucopus	11/35		J

Table 3. cont.

Location	Date	Host	No. Hosts	No. Fleas Col.	Source
Douglas	1945-46	S. hispidus	21/57		J
Douglas	1945-46	M. ochrogaster	25/414		J
Douglas	1945-46	P. pinetorum	2/21		J
Ril.&Pott.	1956-58	C. latrans	140	5	G
	25. Orchopeas sexdentatus pennsylvanicus (Jordan) 1928				
Riley	IV-10-41	N. floridana		2	B
Douglas	XI-11-44	N. floridana	nest		K
Douglas	IV-18-47	N. floridana			K
Rawlins	VIII-17-50	N. floridana			K
Douglas	XII-24-46	N. floridana			K
	28. Thrassis fotus (Jordan) 1925				
Morton		Citellus spilosoma			Hu
Morton		O. leucogaster			Hu
Meade		O. leucogaster			Hu
	29. Peromyscopsylla hesperomys (Baker) 1904				
Clark	XI-24-55	O. leucogaster			K
	30. Peromyscopsylla scotti Fox 1939				
Douglas	1945-46	P. leucopus	2/35		J
Douglas	XI-17-45	P. leucopus			K

small mammals in Kansas. These flea species are listed and discussed in the order in which they appear in Jellison et al. (1953).

1.[1] Cediopsylla simplex (Baker) 1895

Kansas Hosts: Sylvilagus floridanus, Canis latrans, Vulpes fulva

This flea was collected on the Florida cottontail, Sylvilagus floridanus, and one of its predators, the red fox, Vulpes fulva. Six C. simplex and 42 Hoplopsyllus glacialis affinis were caught on two cottontails in Riley County in January and December, 1959 (Table 2).

Generally distributed in the United States east of the 100th meridian, C. simplex is common on cottontails and on various predators which are probably accidental hosts. Stannard and Pietsch (1958) stated that in Illinois, it was the most numerous flea on the cottontail and that the flea occured at a low incidence in the winter.

2. Hoplopsyllus glacialis affinis (Baker)

Kansas Hosts: Lepus californicus, Sylvilagus floridanus, Canis latrans

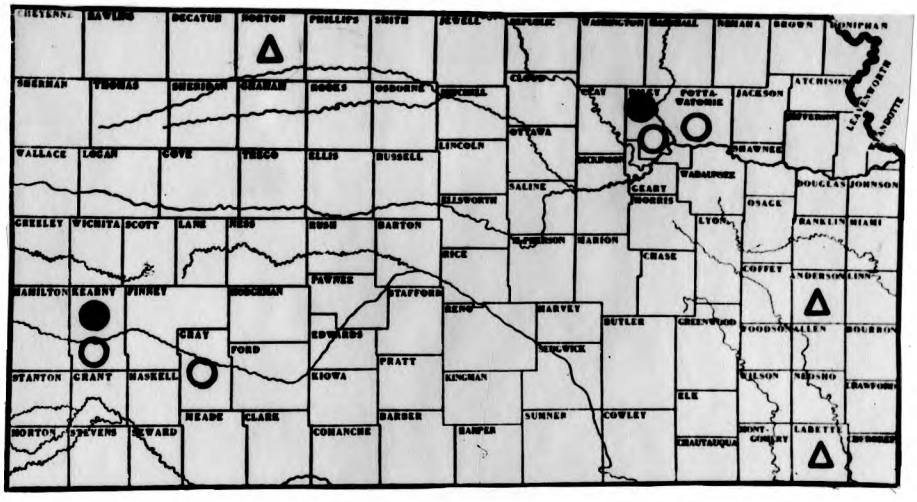

Figure 1. Records of Hoplopsyllus glacialis in Kansas.[2]

[1]Reference numbers of each flea species are consistent throughout this presentation for cross reference purposes.

Collection records indicate it is probably statewide in distribution, being found on both the cottontail and the jackrabbit, Lepus californicus. Kohls (1940) indicated those rabbits were the usual hosts and that the flea ranges north and east from Arizona into Iowa. This distribution differs from other fleas since most are either continental in distribution or limited generally to the East or the West.

3. Echidnophaga gallinacea (Westwood)

Kansas Hosts: no hosts reported

The "sticktight" or hen flea, a common pest of poultry, is also found on mammals. It was recorded from Kansas by Trembly and Bishop (1940), no locality or host being given.

4. Pulex simulans Baker

Kansas Hosts: Didelphis virginiana, Cynomys ludovicianus, Canis latrans, Vulpes fulva

This species was long misidentified as Pulex irritans (Smit, 1958). Four specimens were taken from a red fox, Vulpes fulva, and one from an oppossum, Didelphis virginiana, in Riley County and seven from a prairie dog, Cynomys ludovicianus, in Hamilton County. Gier and Ameel (1959) stated P. simulans was the most common flea on the coyote, Canis latrans, in Kansas and discussed its relationship to P. irritans. In view of the fact that P. simulans occured on a wide variety of wild animals and was abundant in Kansas on coyotes, the four specimens recorded as P. irritans from Kearny County by El Rawi (1957) from the jackrabbit are considered here to be P. simulans (Table 3). Also a report by Trembly and Bishop (1940) of P. irritans from Reno and Riley Counties

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[2]Symbols used in this and the following figures are: solid dot - collection record in present study; open circle - published record; and triangle - unpublished record in museum.

is questionable and is considered to be P. simulans until further investigation is undertaken. Smit (1958) stated that P. simulans has a wide range of distribution in the Americas, from the northwestern United States to the northern half of South America.

5. Ctenocephalides canis (Curtis)

Kansas Hosts: Canis latrans, Vulpes fulva

The only records in Kansas were eight specimens reported by Gier and Ameel (1959) from the coyote and one specimen from the red fox in the University of Kansas museum. C. canis, the "dog flea", is found generally throughout the inhabited areas of the United States, mostly on domestic dogs and cats.

6. Ctenocephalides felis (Bouche)

Kansas Hosts: Didelphis virginianus, Vulpes fulva

One hundred and eight specimens were collected on one opossum from a garage attic in Manhattan, Kansas, and one was collected from a red fox caught near Manhattan. Two other records on the opossum were found (Table 3). Called the "cat flea", C. felis is distributed on domestic dogs and cats similar to its near relative the "dog flea".

7. Xenopsylla cheopis (Rothschild)

Kansas Hosts: Rattus norvigicus

No record in Kansas has been reported since Grundman et al. (1941) reported its occurrence on Norway rats, Rattus norvigicus, at the Manhattan City dump, and Ackert et al. (1941) reported it overwintered there. X. cheopis is called the "Oriental rat flea" and is cosmopolitan in distribution. It has caused the deaths of millions of people by transmitting the bubonic plague organism, Pasteurella pestis, from rats to man.

8. Cheatopsylla lotoris (Stewart)

Kansas Hosts: Canis latrans, Urocyon cinereoargenteus, Procyon lotor, Taxidea taxus

Five specimens were taken from a grey fox, Urocyon cinereoargenteus, and Gier and Ameel (1959) reported 33 specimens from 14 coyotes and Gier (unpublished data) had 12 specimens from a raccoon, Procyon lotor, killed March 12, 1959 in Riley County, and several specimens from a badger, Taxidea taxus. Other reported hosts in the United States were the raccoon and "den of the red fox" (Johnson, 1955).

9. Stenoponia americana (Baker)

Kansas Hosts: Blarina brevicauda, Reithrodontomys montanus, Reithrodontomys megalotis, Peromyscus maniculatus, Sigmodon hispidus, Microtus ochrogaster.

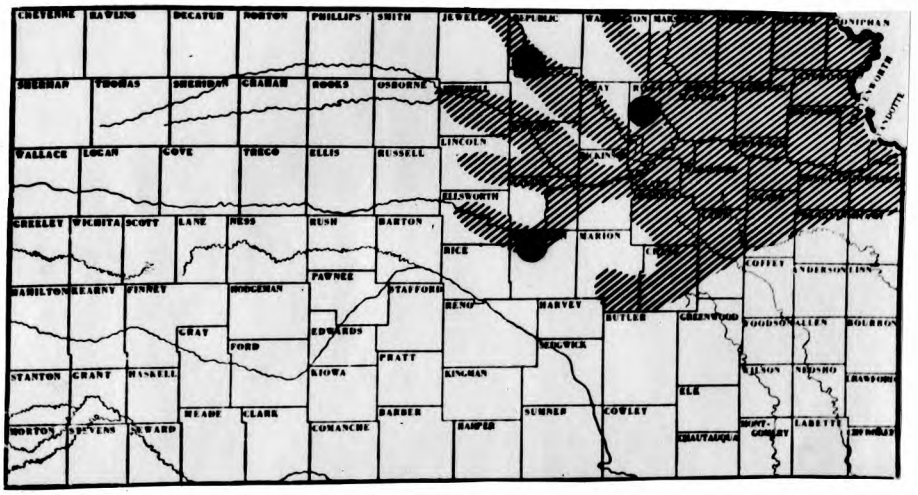

Figure 2. Records of Stenoponia americana in Kansas. Shaded area is the Kansas River Valley Subcenter faunal division.

Previously uncollected in Kansas, five specimens of this flea were taken in Riley County in the fall of 1957 by Dr. H. T. Gier. During the present study, one was taken in the fall of 1958, one in the spring of 1959, and 133 in the fall of 1959. Also in fall 1959, five specimens were collected from

McPherson County and seven from Republic County. This was the most predominant flea collected in Riley County in the fall of 1959, with the cotton rat, Sigmodon hispidus, the deer mouse, Peromyscus maniculatus, and the short-tailed shrew, Blarina brevicauda, most highly infested (Table 5). All collections were from hosts found in the contiguous Kansas River Valley Subcenter faunal division (Cockrum, 1952).

Fox (1940) stated that in the fall and winter S. americana was fairly common on wild mice in the eastern United States and Royal (1952) found it to be the dominant flea on deer mice in Alabama. Records from Riley County indicated that shrews, cotton rats and deer mice were about equally parasitized in the fall of 1959 (Table 5). Until 152 specimens were taken in this study, S. americana had never been reported west of Iowa, except for a few specimens collected in Montana. Many collections of fleas have been made between these locations and this large flea (4 - 5 mm) if present, would not likely be missed.

S. americana, because of its large size, protruded well beyond the hair of its small hosts and occured in numbers of up to 15 on one deer mouse (Col. #153) and 27 on three short-tailed shrews (Col. #145). This high incidence of infestation, coupled with the size of the parasite, would probably affect the health of the host. In Riley County in the fall of 1959, this flea outnumbered other species of fleas usually most often collected on the rodent and shrew hosts (Tables 5 & 6), and was present in large numbers only at that time. Perhaps the factors that caused this sudden increase in numbers of S. americana were inversly related to the success of the species usually most numerous in Riley County and in the majority of other collections.

Twenty live adult S. americana from deer mice were brought into the laboratory on November 11, 1959 for observation. Ten eggs were observed glued in

pairs to paper toweling in the jar cage. These eggs were light brown to tan in color and measured .833 to .921 mm in width and 1.125 to 1.133 mm in length. They were put in vials and kept at 80 percent humidity and 70°F. for four weeks, after which time they were observed shriveled and dried. Ten adult fleas were introduced near a laboratory white mouse caged in a wire box and put in a larger box with dried blood and sand in the bottom. The fleas readily jumped on the mouse, which immediately scratched frantically but soon tired and was observed to breathe heavily with its eyes closed. The fleas attacked around the neck and ears of the mouse and apparently could not be dislodged. Small holes and lines were found in the rearing cage sand from time to time but no eggs or larvae were observed for the three week period until the last flea had died.

10. Epitedia neotomae Jameson

Kansas Hosts: Neotomae floridana, Spilogale interrupta

Reported in the United States only by Jameson (1946), this flea was described from specimens collected in wood rat (Neotoma floridana) nests in Douglas County, Kansas and was collected also from the spotted skunk, Spilogale interrupta, and from a wood rat in Ellsworth County.

11. Epitedia wenmanni (Rothschild)

Kansas Hosts: Blarina brevicauda, Cryptotis parva, Reithrodontomys megalotis, Reithrodontomys montanus, Peromyscus maniculatus, Peromyscus leucopus, Sigmodon hispidus, Neotoma floridana, Microtus ochrogaster

This flea was collected in small numbers from several species of mice, and the deer mouse seemed to be the preferred host (Table 2). Two specimens were found in a cotton rat nest and 150 in a wood rat nest, but it was more often collected on cotton rats than on pack rats (Table 4). An average of two fleas per host was the highest infestation found (Col. #148); only one or two usually were collected in pools of several hosts (Table 2). Collections were

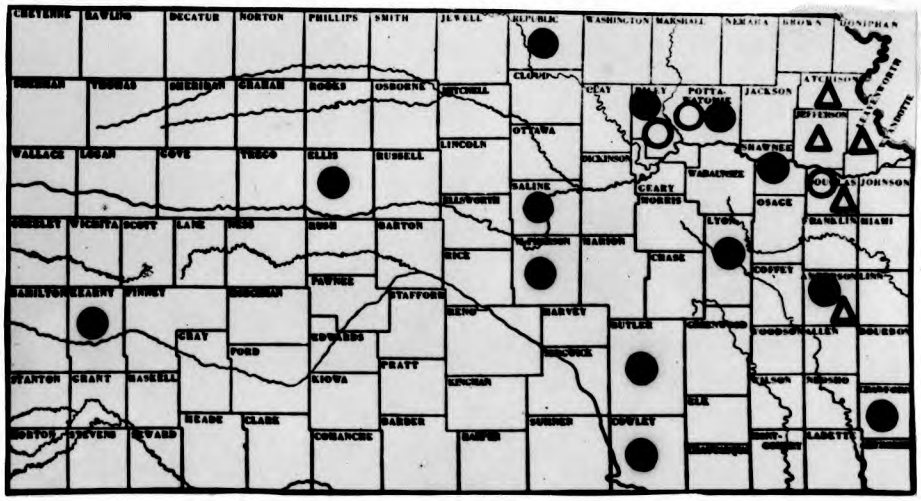

Figure 3. Records of Epitedia wenmanni in Kansas.

made generally over eastern Kansas, with two specimens collected in Kearny County.

This species has been collected on a variety of mice throughout the United States and Canada, and Fox (1940), Hubbard (1947) and the present study (Table 4) indicated the deer mouse to be the preferred host. Probably this flea will be found to be predominantly a nest species for two reasons; first, it was usually collected on many hosts in all seasons of the year, yet it was found rarely in large numbers and more rarely the most numerous on a host. Second, a nest of the wood rat yielded 150 specimens of this flea but only one or two specimens were usually taken during each collection from this host. Even though most often found on the deer mouse in this study, it might prove to be more numerous in the nests of other species.

The relationship in range and abundance between E. wenmanni and E. neotomae in Kansas needs further study. E. neotomae has been reported both east and west of Riley County in nests, yet none were collected in nests or on hosts in this study. Both species have been reported from Douglas County, but Jameson (1946) did not mention if they have been collected in the same nest.

12. Rhadinopsylla (Rectofrontia) fraterna (Baker)

Kansas Hosts: Blarina brevicauda, Microtus ochrogaster

Eight specimens of this species were collected in Riley County, one on a prairie vole in November, 1958 and seven on nine short-tailed shrews in November, 1959 (Table 2). Jameson (1947) reported that one percent of 414 prairie voles collected in Douglas County were parasitized by R. fraterna.

This flea apparently ranges from coast to coast in North America, being collected on various hosts in quite varied habitats. For example, one specimen was taken in Maryland, others in Canada, Montana, South Dakota, Wyoming, New Mexico, Oregon, and now from Kansas. Hosts vary from the cony, Ochotona spp., found high in the mountains, to the short-tailed shrew in the plains of Kansas. The most specimens believed obtained in one collection were the seven collected in the present study from the short-tailed shrew, which also is a first reported collection on shrews. Jameson (1947) stated this flea might prove to be a nest species, as it was collected by Beamer from a "mouse" nest in Douglas County. The seven specimens collected on shrews were taken during the high population of S. americana and the seeming reduction in the usual common flea species.

13. Corrodopsylla curvata curvata (Rothschild)

Kansas Hosts: Blarina brevicauda

Prior to the four specimens collected from short-tailed shrews in Riley County, this species had not been collected in Kansas. Fifty-four short-tailed shrews were examined and 5.6 percent were parasitized by this flea (Table 4). C. curvata is a true shrew flea (Fox, 1940), its type host being the short-tailed shrew, and its present range seems to be everywhere east of the Great Basin (Hubbard, 1947).

14. Corrodopsylla hamiltoni Traub

Kansas Hosts: Cryptotis parva, Blarina brevicauda

Jameson (1947) reported numerous specimens on the little short-tailed shrew, Cryptotis parva, and the short-tailed shrew in Douglas County, the only Kansas records. Traub (1944) described this flea from the short-tailed shrew in Illinois and since then it has been collected in New York and Missouri (Enns, 1947) and in Kansas. C. hamiltoni is apparently restricted to shrews, seeming to prefer Cryptotis.

15. Ctenophthalmus pseudagyrtes Baker

Kansas Hosts: Blarina brevicauda, Scalopus sp., Sylvilagus floridanus, Reithrodontomys megalotis, Peromyscus maniculatus, Peromyscus leucopus, Sigmodon hispidus, Microtus ochrogaster, Vulpes fulva

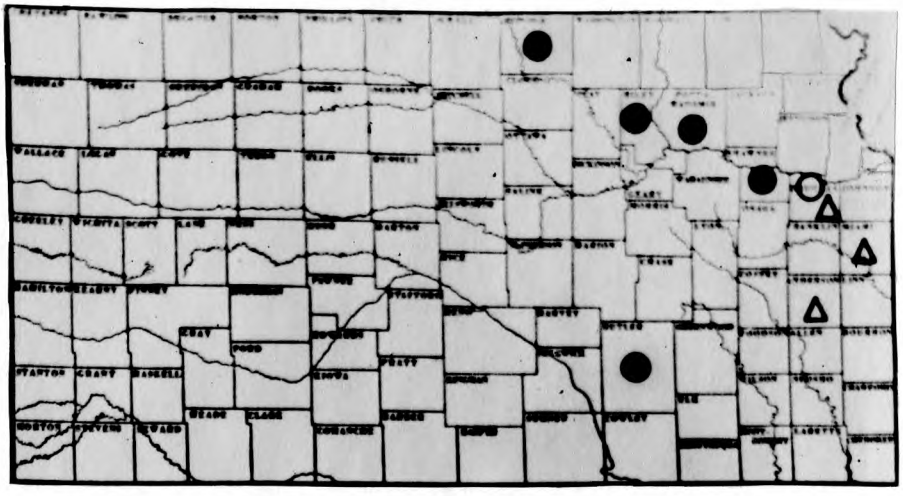

Figure 4. Records of Ctenophthalmus pseudagyrtes in Kansas.

Of the 39 specimens collected from the short-tailed shrew, the harvest mouse, Reithrodontomys megalotis, the deer mouse, the prairie vole, and a cotton rat nest, 32 were collected in Riley County, seven in Republic County, and one each from Shawnee, Butler and Pottawatomie Counties. It accounts for 2.9 percent of the total fleas on the prairie vole, 19.7 percent on the short-

tailed shrew, and 1.1 percent on the deer mouse.

C. pseudagyrtes is one of the most abundant fleas on small mammals in the eastern United States (Fox, 1940), as far west perhaps as Douglas County, Kansas where Jameson (1947) found it to be the most abundant flea on the short-tailed shrew, the prairie vole, and the woodland pine mouse, Pitymys pinetorum. In the present more statewide study, Orchopeas leucopus was found in much larger numbers on the prairie vole, but C. pseudagyrtes would have been the most abundant on the short-tailed shrew if the large number of Stenoponia americana collected only in Riley County is disregarded. C. pseudagyrtes has been taken once in Kansas on the mole, Scalopus sp., the indicated preferred host by Fox (1940). Jameson (1950) stated that this flea was not taken commonly from true nocturnal hosts such as the deer mouse, perhaps explaining the 1.1 percent found on that host in the present study. The reported collection of this flea in Montana but nowhere between there and Nebraska (Rapp and Gates, 1957) indicates a peculiar distribution similar to that of S. americana.

16. Doratopsylla blarinae Fox

Kansas Hosts: Microtus ochrogaster

One specimen has been collected in Douglas County (Jameson, 1947). Kansas is probably the westernmost extension of the range of this common eastern shrew flea which is replaced in the Mid-west by Corrodopsylla curvata (Hubbard, 1947). Jameson (1950) found D. blarinae to be the most common flea on the short-tailed shrew in the eastern United States and Ctenophthalmus pseudagyrtes the next most abundant.

17. Anomiopsyllus hiemalis (Eads and Menzies)

Kansas Hosts: Neotoma micropus

The only record in Kansas was found in the University of Kansas collection, from the grey wood rat, Neotoma micropus, which is restricted to southwestern Kansas. This flea, collected in Barber County is probably limited to the distributional area of its host.

18. Conorhinopsylla nidicola Jellison

Kansas Hosts: Peromyscus maniculatus, Neotoma floridana, Canis latrans

Three specimens were collected in Riley County from the deer mouse and wood rat and two in Republic County from the deer mouse. Jellison (1945) described it from specimens collected in wood rat nest studies in Douglas County (see Epitedia neotomae) and it has since been reported on a coyote in Pottowatomie County by Gier and Ameel (1959). The only other record was a collection in Cache County, Oklahoma (Jellison, 1945).

19. Odontopsyllus dentatus (Baker)

Kansas Hosts: Sylvilagus floridanus

Only one specimen from Anderson County is known from Kansas, present in the collection at the University of Kansas. This represents an extension of the known range from Colorado (Eads, 1949) into eastern Kansas. Hubbard (1947) indicated O. dentatus was a true rabbit flea common to the Rocky Mountains and West.

20. Monopsyllus exilis kansensis Hubbard

Kansas Hosts: Dipodomys ordii, Onychomys leucogaster

In this study, 202 specimens were collected from Finney County, eleven on the kangaroo rat, Dipodomys ordii, and 191 on the grasshopper mouse, Onychomys leucogaster. The subspecies, M. e. kansensis was described by Hubbard from two males taken in Meade County from the grasshopper mouse. The female was not previously identified. Because the type species of this sub-

species is common in the West on grasshopper mice, Hubbard (1947) stated that M. e. kansensis was probably common throughout the Great Plains on grasshopper mice. Present data indicated it was abundant, at least in Finney County, on that host. The 11 specimens collected from the kangaroo rat were possibly accidental infestations resulting from its close association with the grasshopper mouse.

21. Nosopsyllus fasciatus (Bosc)

Kansas Hosts: Microtus ochrogaster

Reported from Douglas County, Kansas only by Jameson (1947) this species is the common domestic rat and mouse flea of Europe and North America. It occasionally occurs as an accidental infestation on various wild mammals (Hubbard, 1947).

22. Opisocrostis hirsutus (Baker)

Kansas Hosts: Cynomys ludovicianus

Fifty O. hirsutus were collected from two prairie dogs taken in Hamilton County in the summer of 1959. This species is a true prairie dog flea and occurs in the United States wherever prairie dogs are found (Hubbard, 1947).

23. Orchopeas howardii (Baker)

Kansas Hosts: Lepus californicus, Sciurus carolinensis, Sciurus niger, Glaucomys volans, Peromyscus maniculatus, Microtus ochrogaster, Canis latrans, Vulpes fulva

In Riley County two specimens were collected from a fox squirrel, Sciurus niger, and two from a red fox, and in Clay County seven were collected from a fox squirrel. This flea has been reported on several species of small mammals by Fox (1940) and Hubbard (1947) and has been collected on eight hosts in Kansas (Tables 2 & 3), being statewide in distribution. Gier and Ameel (1959) discussed the occurrence of O. howardii on coyotes, deer mice, and prairie

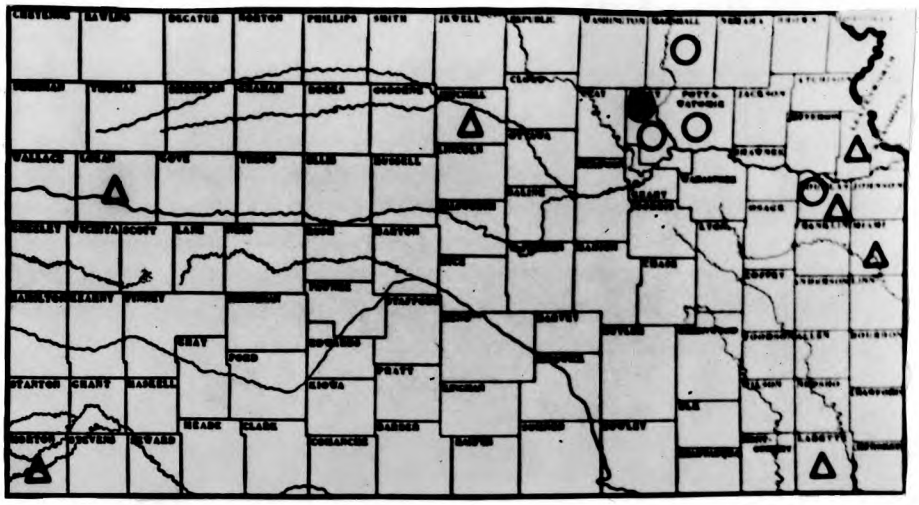

Figure 5. Records of Orchopeas howardii in Kansas.

voles in Kansas. Holland (1949) would restrict this flea to the grey squirrel Sciurus carolinensis, but Hubbard (1947), Fox (1940) and the present study indicate it was common also on other squirrels. Fox (1940) stated it was one of the most common fleas in the East.

24. Orchopeas leucopus (Baker)

Kansas Hosts: Blarina brevicauda, Sylvilagus floridanus, Perognathus hispidus, Reithrodontomys megalotis, Reithrodontomys montanus, Peromyscus maniculatus, Peromyscus leucopus, Sigmodon hispidus, Pitymys pinetorum, Microtus ochrogaster, Canis latrans

O. leucopus was the most abundant flea on small mammals collected in this study. A total of 886 specimens was recovered from eight species of hosts (Table 2) and records of its occurrence on three additional hosts were found (Table 3). This flea accounted for 91.1 percent of 643 fleas taken on 159 prairie voles, 79.1 percent of 134 fleas from 262 cotton rats and 60.1 percent of 266 fleas from 249 deer mice and was distributed generally over eastern Kansas. In Riley County, it was most abundant on prairie voles and

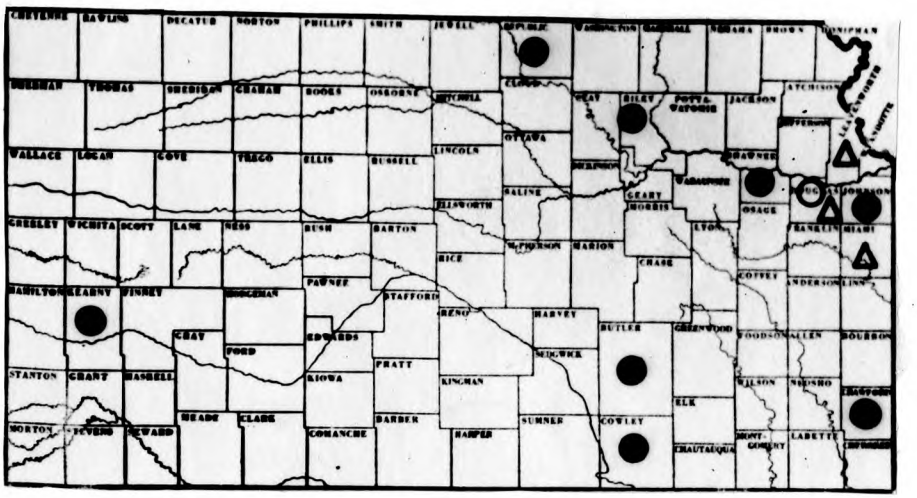

Figure 6. Records of Orchopeas leucopus in Kansas.

cotton rats in March and April (Table 5). Occasionally as many as 20 specimens were found on one prairie vole (Col. #39) and 23 on one deer mouse (Col. #70), and averages of around ten per host were not uncommon.

O. leucopus has been found throughout the eastern United States and only occasionally west of the 100th meridian (Hubbard, 1947), occurring on various small mammals. Gier and Ameel, (1959) considered its occurrence on coyotes to be incidental to the feeding habits of the coyote.

On two occasions (Col. #21 and 23) specimens of O. leucopus were observed active after being frozen for 19 days. One of these collections was stored in an outdoor shelter when the temperature reached -24°F. This observation warrents further investigation, for the ability to survive in a frozen condition could be an important survival factor to overwintering fleas and no other report of this being observed has been noted.

Parker and Johnson (1957), working with O. leucopus, performed the first proved transmission of the tularemia organism, Pasturella tularensis, from animal to animal by a flea vector. This flea was used because it was easily

reared in the laboratory, a task rarely accomplished for fleas of wild animals.

25. Orchopeas sexdentatus pennsylvanicus (Jordan)

Kansas Hosts: Neotoma floridana

This true wood rat flea was recovered to the extent of 13 specimens from five wood rats and 33 from a wood rat nest. The five other records, in Douglas and Rawlins Counties, were also from the wood rat (Table 3). The subspecies, O. s. pennsylvanicus, has been reported as common on wood rats east of the 100th meridian in the United States (Fox, 1940), and was outstanding for a commonly collected flea in that it had never been taken from any host but the wood rat.

26. Thrassis sp. Jordan

Kansas Hosts: Dipodomys ordii, Onychomys leucogaster

Four fleas identified only to the genus Thrassis were collected from Finney County in April, 1959 from the kangaroo rat and the grasshopper mouse.

27. Thrassis campestris (Prince)

Kansas Hosts: Dipodomys ordii

Five specimens were collected from ten kangaroo rats from Finney County in October, 1959. This species has been collected previously in Nebraska and Oklahoma and probably ranges throughout the western Great Plains (Hubbard, 1947).

28. Thrassis fotus (Jordan)

Kansas Hosts: Citellus spilosoma, Onychomys leucogaster

This flea was reported by Hubbard (1947) from Meade and Morton Counties from the spotted ground squirrel, Citellus spilosoma, and the grasshopper mouse. Not commonly collected, it ranges east of the Rocky Mountains.

29. Peromyscopsylla hesperomys (Baker)

Kansas Hosts: Onychomys leucogaster

The specimen in the University of Kansas collection was the only record in Kansas. Furthermore, although found in the East and Northwest United States on deer mice, this species has never before been reported from the central United States nor from the grasshopper mouse.

30. Peromyscopsylla scotti Fox

Kansas Hosts: Peromyscus leucopus

Found only on the wood mouse, Peromyscus leucopus, three specimens were taken in November, 1959 from Johnson County, Kansas; and Jameson (1947) reported it from Douglas County. Other occurrences have been reported only in Iowa and Massachusetts from the wood mouse (Fox, 1940).

Using all the collection records of fleas obtained, a host-flea index is compiled which includes the total number of fleas collected on each host and the total number of hosts of each species examined in this study (Table 4). Sufficient data were obtained from collections in Riley County for four seasons during the study period to indicate seasonal variation in abundance of each flea species on five commonly collected hosts (Table 5). These data are also arranged to show seasonal variation in the average number of the four most abundant flea species on each of the five hosts (Table 6).

The most abundant flea species collected usually were found on more than one species of small mammal host in the same habitat and seemed to exhibit little host preference. A collection of six short-tailed shrews (Col. #150) and 14 deer mice (Col. #151) each yielded five species of fleas, and short-tailed shrews accounted for six species of fleas in Riley County in the fall of 1959 (Table 6). At the other extreme, several pack rats were caught in the same habitat as these hosts, yet Orchopeas s. pennsylvanicus was restricted

Table 4. Records of species of fleas collected on various hosts in Kansas.

Host	Flea	Present study Number Collected on host : in nest	Other Records
Didelphis virginiana virginiana Kerr 1 examined			
	Pulex simulans	1	
	Ctenocephalides felis	108	H[a], K[b]
Blarina brevicauda brevicauda (Say) 54 examined			
	Stenoponia americana	38	
	Epitedia wenmanni	4	
	Rhadinopsylla fraterna	7	
	Corrodopsylla c. curvata	4	
	Corrodopsylla hamiltoni		1/13[c], J[d]
	Ctenophthalmus pseudagyrtes	14	5/13 J
	Orchopeas leucopus	4	
Cryptotis parva parva (Say) 12 examined			
	Epitedia wenmanni	1	
	Corrodopsylla hamiltoni		K, 16/34 J
Scalopes aquaticus machrinoides Jackson 1 examined			
	Ctenophthalmus pseudagyrtes		K
Lepus californicus melanotis Mearns			
	Hoplopsyllus g. affinis		E[e]

[a]Hopkins and Rothschild (1956)
[b]Snow Entomological Collection, University of Kansas
[c]Number of hosts infested/total hosts examined
[d]Jameson (1947)
[e]El Rawi (1957)

Table 4. cont.

Host	Flea	Present Study Number Collected on host : in nest	Other Records
	Pulex irritans (simulans?)		E, T[f]
	Orchopeas howardi		K
Sylvilagus floridanus sp. 4 examined			
	Cediopsylla simplex	6	H, K
	Hoplopsyllus g. affinis	56	K
	Ctenophthalmus pseudagyrtes		K
	Odontopsyllus dentatus		K
	Orchopeas leucopus		K
Sylvilagus aquaticus aquaticus (Bachman)			
	Hoplopsyllus g. affinis		K
Sciurus carolinensis carolinenis (Gmelin)			
	Orchopeas howardi		K
Sciurus niger refuventer Geoffroy 3 examined			
	Orchopeas howardi	9	K, B[g]
Cynomys ludovicianus ludovicianus (Ord) 2 examined			
	Pulex simulans	7	
	Opisocrostis hirsutus	50	K
	Peromyscopsylla hesperomys		K
Citellus spilosoma major (Merriam) 1 examined			

[f]Trembley and Bishop (1940)
[g]Rothschild Collection of fleas, British Museum of Natural History

Table 4. cont.

Host	Flea	Present Study Number Collected on host : in nest	Other Records
	Thrassis fotus		Hu[h]
Glaucomys volans volans (Linneaus)			
	Orchopeas howardi		B
Perognathus hispidus spilotus Merriam 1 examined			
	Orchopeas leucopus	1	
Dipodomys ordii richardsoni (Allen) 114 examined			
	Monopsyllus exilis kansensis	11	
	Thrassis sp.	1	
	Thrassoides campestris	5	
Onychomys leucogaster arctires Rhoads 57 examined			
	Monopsyllus exilis kansensis	191	Hu
	Thrassis sp.	1	
	Thrassis fotus		Hu
	Peromyscopsylla hesperomys		K
Reithrodontomys megalotis dychei Allen 34 examined			
	Stenoponia americana	2	
	Epitedia wenmanni	1	
	Ctenophthalmus pseudagyrtes	1	
	Orchopeas leucopus	1	

[h]Hubbard (1947)

Table 4. cont.

Host	Flea	Present Study Number Collected on host : in nest	Other Records
Reithrodontomys montanus griseus Bailey 13 examined			
	Stenoponia americana	4	
	Epitedia wenmanni	1	
	Orchopeas leucopus	11	
Peromyscus maniculatus sspp. (Hoy & Kennicott) 249 examined			
	Stenoponia americana	58	
	Epitedia wenmanni	43	K
	Ctenophthalmus pseudagyrtes	3	
	Conorhinopsylla nidicola	2	
	Orchopeas howardi		G[i]
	Orchopeas leucopus	160	18/34 J
Peromyscus leucopus noveboracensis (Fischer) 33 examined			
	Epitedia wenmanni	1	K, B, 3/35 J
	Ctenophthalmus pseudagyrtes	1	
	Orchopeas howardi		K
	Orchopeas leucopus	4	K, B, 11/35 J
	Peromyscopsylla scotti	3	
Sigmodon hispidus texianus (Audubon & Bachman) 262 examined			
	Stenoponia americana	12	

[i] Gier and Ameel (1959)

Table 4. cont.

Host	Flea	Present Study Number Collected on host : in nest		Other Records
	Epitedia wenmanni	16		K
	Ctenophthalmus pseudagyrtes		1	2/57 J
	Orchopeas leucopus	106	11	K, B, 21/57 J
Neotoma floridana osagensis Blair 13 examined				
	Epitedia neotomae			J 46[j], B
	Epitedia wenmanni	3	150	K, B
	Conorhinopsylla nidicola	1		B, Je[k]
	Orchopeas s. pennsylvanicus	13	33	K, B
Neotoma micropus micropus Baird				
	Anomiopsyllus hiemalis			K
Pitymys pinetorum nemoralis (Bailey)				
	Ctenophthalmus pseudagyrtes			K, 11/21 J
	Orchopeas leucopus			2/21 J
Microtus ochrogaster ochrogaster (Wagner) 159 examined				
	Stenoponia americana	31		
	Epitedia wenmanni	6		8/414 J
	Rhadinopsylla fraterna	1		4/414 J
	Ctenophthalmus pseudagyrtes	19		K, 103/414 J
	Doratopsylla blarinae			K
	Nosopsyllus fasciatus			K, 4/414 J

[j]Jameson (1946)
[k]Jellison (1945)

Table 4. cont.

Host	Flea	Present Study Number Collected on host : in nest	Other Records
	Orchopeas howardi		G, 4/414 J
	Orchopeas leucopus	586	K, 25/414 J
Rattus norvigicus norvigicus (Berkenhout)			
	Xenopsylla cheopis		Gr[1]
Canis latrans Say			
	Cediopsylla simplex		G
	Hoplopsyllus g. affinis		G
	Pulex simulans		G
	Ctenocephalides canis		G
	Chaetopsylla lotoris		G
	Conorhinopsylla nidicola		G
	Orchopeas howardi		G
	Orchopeas leucopus		G
Vulpes fulva fulva (Desmarest) 2 examined			
	Cediopsylla simplex	1	
	Pulex simulans	4	
	Ctenocephalides canis		K
	Ctenocephalides felis	1	
	Ctenophthalmus pseudagyrtes		K
	Orchopeas howardi	2	

[1]Grundman et al. (1941)

Table 4. cont.

Host	Flea	Present Study Number Collected on host : in nest	Other Records
Urocyon cinereoargenteus ocythous Bangs 1 examined			
	Chaetopsylla lotoris	5	
Procyon lotor hirtus Nelson and Goldman			
	Chaetopsylla lotoris		Gi[m]
Taxidea taxus taxus (Schreber)			
	Chaetopsylla lotoris		Gi
Spilogale interrupta (Rafinesque)			
	Epitedia neotomae		J 46

[m]Gier, unpublished data

Table 5. Numbers of various species of fleas collected on five common hosts in Riley County, Kansas.

Host	Flea	Number Collected Nov 1958	Mar-Apr 1959	Jun-Jul 1959	Nov 1959
Blarina brevicauda		18	2	1	10
	Stenoponia americana	0	0	0	38
	Epitedia wenmanni	0	0	0	4
	Rhadinopsylla fraterna	0	0	0	7
	Corrodopsylla c. curvata	1	3	0	0
	Ctenophthalmus pseudagyrtes	9	0	0	3
	Orchopeas leucopus	2	0	0	2
	Total Fleas	12	3	0	54
	Mean fleas on each host	.67	1.5	1	5.4
Reithrodontomys spp.		0	1	0	19
	Stenoponia americana	0	0	0	5
	Epitedia wenmanni	0	0	0	1
	Ctenophthalmus pseudagyrtes	0	0	0	1
	Orchopeas leucopus	0	7	0	4
	Total Fleas	0	7	0	11
	Mean fleas on each host	0	7	0	.58
Peromyscus spp.		16	14	18	27
	Stenoponia americana	0	0	0	54
	Epitedia wenmanni	1	2	0	6
	Ctenophthalmus pseudagyrtes	0	0	1	1
	Orchopeas leucopus	9	7	4	11
	Conorhinopsylla nidicola	0	0	0	2
	Total Fleas	10	9	5	74
	Mean fleas on each host	.62	.64	.28	2.7
Sigmodon hispidus		13	1	4	4
	Stenoponia americana	0	0	0	9
	Epitedia wenmanni	1	1	0	8
	Orchopeas leucopus	4	4	0	2
	Total Fleas	5	5	0	19
	Mean fleas on each host	.38	5	0	4.7
Microtus ochrogaster		42	32	0	19
	Stenoponia americana	1	1	0	27
	Epitedia wenmanni	0	3	0	1
	Rhadinopsylla fraterna	1	0	0	0
	Ctenophthalmus pseudagyrtes	1	11	0	0
	Orchopeas leucopus	46	337	0	14
	Total Fleas	49	353	0	42
	Mean fleas on each host	1.16	11	0	2.2

Table 6. Average number of collections of the four most abundant fleas from five common hosts in Riley County, Kansas.

Flea	Host	November 1958		Mar-Apr 1959		Jun-Jul 1959		November 1959	
		Hosts	Mean Fleas:	Hosts	Mean Fleas:	Hosts	Mean Fleas:	Hosts	Mean Fleas
Stenoponia americana									
	Blarina brevicauda	18	0	2	0	1	0	10	3.8
	Reithrodontomys sp.	0	0	1	0	0	0	19	.3
	Peromyscus sp.	16	0	14	0	18	0	27	2.0
	Sigmodon hispidus	13	0	1	0	4	0	4	2.2
	Microtus ochrogaster	42	.1	32	.1	0	0	19	1.4
Epitedia wenmanni									
	Blarina brevicauda	18	0	2	0	1	0	10	.4
	Reithrodontomys sp.	0	0	1	0	0	0	14	.1
	Peromyscus sp.	16	.1	14	.1	18	0	27	.2
	Sigmodon hispidus	13	.1	1	1.0	4	0	4	2.0
	Microtus ochrogaster	42	0	32	.1	0	0	19	.1
Ctenophthalmus pseudagyrtes									
	Blarina brevicauda	18	.5	2	0	1	0	10	.3
	Reithrodontomys sp.	0	0	1	0	0	0	19	.1
	Peromyscus sp.	16	0	14	0	18	.1	27	.1
	Sigmodon hispidus	13	0	1	0	4	0	4	0
	Microtus ochrogaster	42	.1	32	.3	0	0	19	0
Orchopeas leucopus									
	Blarina brevicauda	18	.1	2	0	1	0	10	.2
	Reithrodontomys sp.	0	0	1	7.0	0	0	19	.2
	Peromyscus sp.	16	.5	14	.5	18	.2	27	.4
	Sigmodon hispidus	13	.3	1	4.0	4	0	4	.5
	Microtus ochrogaster	42	1.1	32	10.5	0	0	19	.7

without exception to pack rats. Except for a few Orchopeas howardi on mice, congeneric species of fleas were not found on the same host and thus did not compete with each other.

Generally, fleas on small mammals in Kansas were found to be most abundant in the fall and spring; only 14 fleas were found on 26 hosts live-trapped during the summer of 1959. Fleas were most abundant from all stations in March of 1959, during a time when the mammal population had been reduced severly from the preceeding fall's peak populations. Three deer mice were the only animals collected in the three nights of trapping in Saline County during this month, and 70 fleas were collected from these animals. Also in Riley County, numbers of 20 to 25 Orchopeas leucopus per animal were not uncommon (Table 2) and the average numbers of fleas per host were the highest recorded (Tables 5 and 6). Apparently during a reduction in host populations, fleas concentrate on the remaining animals. This could conceivably cause the remaining animals to progressively become less resistent to the factors causing the population reduction.

SPECIAL CONSIDERATIONS

Data obtained from this study were largely qualitative because the host animals were snap-trapped, hence killed, and were picked up at varying intervals after capture by the cooperators in the Small Mammal Census. Fleas leave dead hosts at different rates depending upon climatic conditions and species of flea, hence to obtain quantitative data, the host must be live-trapped. Twenty-six hosts were live-trapped in the summer of 1959, but as flea infestations were light in the summer months, few fleas were obtained and no comparisons could be made. Jameson (1947) found an average of 3.4 fleas on 29

live-trapped hosts and 1.3 fleas on 27 snap-trapped hosts.

Variations in seasonal abundance of fleas on hosts occurred for several species of fleas (Table 5 and 6) and this is a well known occurrence for many fleas. Where the adults occur when not on the hosts in certain seasons has not been explained (Jameson & Brennan, 1957) but presumably they are in the host's nest. Also, several species of fleas are common in host nests but rarely found on the host (Howell, 1955). Regular collection of fleas from the nests should be included in a truly quantitative analysis of flea populations but this was far beyond the scope of the present study.

To obtain the most stable flea index, which is the mean number of fleas per infested host (Cole and Koepke, 1947), the number of fleas on each host and the number of hosts infested with fleas has to be recorded. This was impossible in this study because hosts came to the laboratory in pools of each host species and flea interchange could have taken place before the hosts were frozen.

A study of this magnitude yields data on distribution, host preference, and relative numbers of fleas and hosts present in the habitat but certain observations must be weighed carefully in order not to draw conclusions based on insufficient data. Positive data were reported but negative data was not reliable and no negative inferrences have been drawn because of the limited trappings in any one habitat and variable climatic and microenvironmental conditions. For example, if a certain species of flea was not found on a particular host or in a particular locale, inferences could not be made from the data obtained in this study that the flea did not parasitize that particular host or was not found in that habitat.

The unequal distribution of fleas on hosts and their response to environ-

mental and many other factors enter into proper evaluation of host preferences. Morlan is quoted in Kartman et al. (1958) as stating:

> "Where data from extensive collections of all possible hosts at all seasons of the year are available, the percentage of animals infested with one or more parasites and the mean number of parasites per examined animal are usually sufficient to indicate host preference. In cases of inadequate collections ... host preference will remain unknown in spite of any additional manipulation of insufficient data."

Clear-cut distinctions in host preferences are important when evaluating the problem of flea transfer between host species, a major factor in the ecology and disease transmission potential of fleas.

The nature of the Small Mammal Census has proven excellent for an ectoparasite study, as climatic factors, environmental factors, and host abundancy and age are recorded. The practice of taking the animals by snap-traps and the procedure of removal of hosts from traps at 12 or 24 hour intervals has precluded a quantitative study. A qualitative study however, was prerequisite to further ecological evaluation and has added data towards establishing host-ectoparasite relationships, and flea distributions. The information obtained in this study can now be followed by a more thorough quantitative study with consideration to all the aspects of host-ectoparasite-nest relationships not included within the scope of this study.

SUMMARY

Ectoparasites were collected from 1,023 small mammals, representing 24 species, from November, 1958 to November, 1959. A total of 1,783 fleas was collected, mounted and identified, representing nineteen species. Data on an additional eleven species of fleas were located in the literature and in museum collections, making a total of 30 species of fleas known to parasitize

small mammals in Kansas. Data on six of the most abundantly collected fleas follow.

Stenoponia americana was collected sparingly until the fall of 1959 when 133 specimens were taken from six species of hosts, making it the most abundant flea collected in Riley County that season. This large flea (5 mm) was found in numbers of up to 15 on one deer mouse and 27 on three short-tailed shrews. Although common on wild mice in the East, it had never been reported west of Iowa except for a few specimens in Montana. A few eggs of S. americana were observed and an unsuccessful attempt was made to rear adults on a white mouse.

Epitedia wenmanni was found in several collections but never exceeded an average of two fleas per host in any collection of any of the nine host species.

Ctenophthalmus pseudagyrtes was collected from six species of hosts with a total of only 39 specimens. The previous report of dominance of C. pseudagyrtes on prairie voles in Douglas County, perhaps represents the westernmost extension of its occurrence in large numbers.

Monopsyllus exilis kansensis was collected in Finney County abundantly from the grasshopper mouse and ocassionally from the kangaroo rat. Its distribution probably ends in central Kansas where its hosts gradually disappear. Only two males have been collected before; the female was not previously identified.

Orchopeas leucopus was the most abundant flea taken on small mammals. The 886 specimens from eight species of hosts accounted for 91.9 percent of the total fleas on the prairie vole, 79.1 percent on the cotton rat, and 60.1 percent on the deer mouse. Two specimens were observed to have survived being frozen for at least 19 days.

Orchopeas sexdentatus pennsylvanicus was an example of host specific flea, as 13 specimens were collected on five wood rats and 33 from a wood rat nest, but it was not collected from any other host animal.

Other species collected less commonly were Cediopsylla simplex, Hoplopsyllus glacialis affinis, Pulex simulans, Ctenocephalides felix, Chaetopsylla lotoris, Rhadinopsylla fraterna, Corrodopsylla curvata curvata, Conorhinopsylla nidicola, Opisocrostis hirsutus, Orchopeas howardii, Thrassis sp., Thrassis campestris, and Peromsycopsylla scotti. Of the above species and others in museum collections, Stenoponia americana, Corrodopsylla curvata curvata, Doratopsylla blarinae, Anomiopsyllus hiemalis, Odontopsyllus dentatus, Nosopsyllus fasciatus, Opisocrostis hirsutus, Thrassis campestris, Peromyscopsylla hesperomys, and Peromyscopsylla scotti have not previously been reported from Kansas. Flea species reported in the literature but not collected in the present study were Echidnophaga gallinacea, Ctenocephalides canis, Xenopsylla cheopis, Epitedia neotomae, Corrodopsylla hamiltoni, and Thrassis fotus.

A host-flea index was compiled for 30 flea species and 30 mammal host species, combining all known host-flea records from small mammals in Kansas. Known new host records were Chaetopsylla lotoris from the grey fox, Urocyon cinereoargenteus and the badger, Taxidea taxus; Rhadinopsylla fraterna from the short-tailed shrew, Blarina brevicauda; and Peromyscopsylla hesperomys from the grasshopper mouse, Onychomys leucogaster. Data on four flea species from five common hosts in Riley County indicated a seasonal fluctuation in abundance, with fleas at a peak in March. Usual abundant species seemed less numerous in the fall of 1959 when Stenoponia americana was most abundant.

The majority of the most common fleas collected exhibited little host preference. Except for a few Orchopeas howardii occurring with the more common O. leucopus on mice, congeneric species did not parasitize the same species

of host. Generally, fleas were most abundant in March and November, and infestations were higher when host populations were declining.

Data obtained were largely qualitative because most host animals were snap-trapped and collected subsequently at varying intervals by cooperators in the eleven stations of the Small Mammal Census.

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FLEAS (SIPHONAPTERA) OF SMALL MAMMALS IN KANSAS

by

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The aims of this study were (1) to conduct a qualitative survey of the fleas of small mammals in Kansas, (2) to study their occurrence, distribution, relative numbers, and host preference, (3) to accumulate the scattered records of fleas in Kansas, published and unpublished, and (4) to compile a comprehensive list of flea genera and species in Kansas.

A total of 1,023 small mammals representing 24 species was examined from November, 1958 to November, 1959. The majority was shipped to Manhattan by cooperators at eleven stations of the bi-annual Kansas Small Mammal Census; others were collected by the writer. Ectoparasites were removed by the flotation technique and fleas were separated, cleared, and mounted in Hoyer's solution for identification. Kansas flea records from collections at the University of Kansas and the British Museum of Natural History were compiled.

A total of 1,783 fleas, comprising 19 species was collected and additional data on eleven species were obtained to total 30 species now recorded for Kansas. The most abundant species found on small mammals was Orchopeas leucopus, and other abundant fleas were Stenoponia americana, Epitedia wenmanni, Ctenophthalmus pseudagyrtes, Monopsyllus exilis kansensis, and Orchopeas sexdentatus pennsylvanicus. Other species collected less commonly were Cediopsylla simplex, Hoplopsyllus glacialis affinis, Pulex simulans, Ctenocephalides felis, Chaetopsylla lotoris, Rhadinopsylla fraterna, Corrodopsylla curvata curvata, Conorhinopsylla nidicola, Opisocrostis hirsutus, Orchopeas howardii, Thrassis sp., Thrassis campestris, and Peromyscopsylla scotti. Of the above species and others in museum collections, Stenoponia americana, Corrodopsylla curvata curvata, Doratopsylla blarinae, Anomiopsyllus hiemalis, Odontopsyllus dentatus, Nosopsyllus fasciatus, Opisocrostis hirsutus, Thrassis campestris, Peromyscopsylla hesperomys, and Peromyscopsylla scotti

have not previously been reported from Kansas. Flea species reported in the literature but not collected in the present study were Echidnophaga gallinacea, Ctenocephalides canis, Xenopsylla cheopis, Epitedia neotomae, Corrodopsylla hamiltoni, and Thrassis fotus.

A host-flea index was compiled for all records, and known new host records were Chaetopsylla lotoris from the grey fox, Urocyon cinereoargenteus and the badger, Taxidea taxus; Rhadinopsylla fraterna from the short-tailed shrew, Blarina brevicauda; and Peromyscopsylla hesperomys from the grasshopper mouse, Onychomys leucogaster.

Of the six most abundant flea species collected, Orchopeas leucopus, Stenoponia americana, Epitedia wenmanni, and Ctenophthalmus pseudagyrtes were found on six to nine species of hosts, thus exhibiting little host preference. Monopsyllus exilis kansenis was found on two host species and Orchopeas sexdentatus pennsylvanicus was restricted to one host species.

Small mammal fleas were found most abundantly in March and November, especially after a decline in host population. Except for a few Orchopeas howardii occurring with the more common O. leucopus on mice, congeneric species of fleasdid not parasitize the same host species.